Mathematics Learning Area

Introduction

The fundamental purpose of the Mathematics Learning Area is to educate learners to be active, thinking citizens, interpreting the world mathematically and using mathematics to help form their predictions and decisions about personal and financial priorities. Substantial community, social and scientific issues are raised or influenced by public opinion, so it is important that citizens can critically examine those issues from mathematical perspectives.

Teaching and learning of mathematics is viewed as fundamental to the education of learners in our schools and central to the development of our society and our global competitiveness. It is also recognised that the study of mathematics has its own value and beauty and it is intended that learners appreciate the elegance and power of mathematical thinking and experience mathematics as enjoyable (National Curriculum Board, 2008).

The Mathematics Learning Area describes the mathematical knowledge, skills and understandings that learners should have the opportunity to develop in order to become numerate people with numeracy being defined as the capacity, confidence and disposition to use mathematics to meet the demands of learning at school, home, in paid and unpaid work and for participation in community and civic life (adapted National Curriculum Board, 2009).

To fully realise this numeracy perspective in the teaching and learning of mathematics it is necessary to provide opportunities for learners to engage in mathematics in ways that enable them to recognise when mathematics might assist to interpret information or solve practical problems, apply their knowledge appropriately in contexts where they have to use mathematical reasoning processes and choose mathematics that makes sense in the circumstances (MCEETYA, 1997).

The Mathematics Learning Area provides opportunities for learners to develop their

- knowledge and understanding of concepts and skills, and application of skills and processes across key areas of mathematics, eg space, measurement, chance and data, number and algebra
- capacity and disposition to use mathematical knowledge, skills and processes in a range of situations
- capacity to communicate effectively through the use of informal and formal mathematical language, the representation of their mathematical ideas and reasoning in different ways, and the selection and effective use of a range of mathematical strategies, models, and information and communication technologies
- enjoyment of mathematics and confidence in the use of mathematics in everyday situations through appreciation of its relevance as part of their personal and working life, its nature as a dynamic and diverse area of study with interconnected concepts and the nature of mathematical thinking and its historical and cultural roles (National Curriculum Board, 2008).

The Mathematics section of the Northern Territory Curriculum Framework contains:

- a learning progress map of outcomes and key indicators which describe the solid level of performance for each Key Growth Point or Band
- a scope and sequence of indicators for planning and assessing within each Key Growth Point or Band
- a model for designing for teaching and learning in Mathematics including links to curriculum, pedagogy and assessment support materials.

Learning Progress Maps

The Structure of the Observed Learning Outcomes (SOLO) Taxonomy reference has been used as one lens to critically evaluate the Mathematics Learning Area. A range of other empirically evaluated learning frameworks or developmental continua have also been utilised in researching the NTCF Mathematics Learning Area progress maps.

A simplified summary of the SOLO Taxonomy mapped against the NTCF and other research is provided below.

NTCF Bands (approximate)	SOLO Taxonomy	Space and Measurement Strands	Number and Algebra Strands	Chance and Data Strands
Key Growth Point Levels – Band 1	Prestructural (4-6 years)	Van Hiele Levels of Geometrical Thinking: Level 0 Visualisation Teaching Space and Geometry (NSW DET): Early Stage 1 Measurement Framework (NSW DET): Levels1.1/1.2, 2.1/2.2 First Steps Maths Diagnostic Map – Space (WA DET): Emergent, Recognising First Steps Maths Diagnostic Map – Measurement (WA DET): Emergent, Matching and Comparing	Count Me in Too Learning Framework in Number (NSW DET) NZ Maths Framework in Number: Stages 0-5 (Levels 1-2) Talking Pattern and Algebra (NSW DET): Early Stage 1 First Steps Maths Diagnostic Map – Number (WA DET): Emergent, Matching and Comparing	First Steps Maths Diagnostic Map – Chance and Data (WA DET): Emergent
Bands 1 – 2	Unistructural (7-9 years) Indicative Verbs: identify memorise do simple procedure	Van Hiele Levels of Geometrical Thinking: Level 1 Analysis Teaching Space and Geometry (NSW DET): Stage 1/Stage 2 Measurement Framework (NSW DET): Levels 3.1/3.2, 4.1/4.2	Count Me in Too Learning Framework in Number (NSW DET) NZ Maths Framework in Number: Stages 5-6 (Levels 2-3)	First Steps Maths Diagnostic Map – Chance and Data (WA DET): Quantifying, Matching and Comparing, Partitioning

NTCF Bands (approximate)	SOLO Taxonomy	Space and Measurement Strands	Number and Algebra Strands	Chance and Data Strands
Bands 1 – 2		First Steps Maths Diagnostic Map – Space (WA DET): Recognising, Describing First Steps Maths Diagnostic Map – Measurement (WA DET): Quantifying, Measuring	Talking Pattern and Algebra (NSW DET): Stage 1/Stage 2 First Steps Maths Diagnostic Map – Number (WA DET): Quantifying, Partitioning	
Bands 3 - 4	Multistructural (10-12 years) Indicative Verbs: classify describe list combine	Van Hiele Levels of Geometrical Thinking: Level 2 Abstraction Teaching Space and Geometry (NSW DET): Stage 3 Measurement Framework (NSW DET): Levels 5.1/5.2, 6.1/6.2 First Steps Maths Diagnostic Map – Space (WA DET): Describing, Analysing First Steps Maths Diagnostic Map – Measurement (WA DET): Measuring, Relating	Count Me in Too Learning Framework in Number Refer to Counting On Teaching Activities (NSW DET) First Steps Maths Diagnostic Map – Number (WA DET): Factoring, Operating NZ Maths Framework in Number: Stages 6-8 (Levels 3-5) Talking Pattern and Algebra (NSW DET): Stage 3	First Steps Maths Diagnostic Map – Chance and Data (WA DET): Factoring and Measuring, Operating and Relating
Band 5 – 5+	Relational (13-15 years) Indicative Verbs: compare contrast explain causes integrate analyse relate apply	Van Hiele Levels of Geometrical Thinking: Level 3 Deduction First Steps Maths Diagnostic Map – Space (WA DET): Relating		
University level	Extended Abstract (16+ years) Indicative Verbs: theorise generalise hypothesize reflect generate	Van Hiele Levels of Geometrical Thinking: Level 4 Rigor		

Organisation

The outcomes for the Mathematics Learning Area progress maps have been organised into five strands: Space, Measurement, Chance and Data, Number and Algebra from the Key Growth Points to Band Five+. It should be noted that there are some aspects of the Space and Measurement strands that overlap, and there are also significant connections between aspects of the Number and Algebra strands.

Strands	Elements
Space The Space strand provides opportunities for learners to develop and use spatial or geometric concepts and spatial reasoning to solve problems.	**3D objects and 2D shapes** • construct and represent 3D objects and 2D shapes • identify and classify 3D objects and 2D shapes, describing features and properties of 3D objects and 2D shapes and developing mathematical arguments about geometric relationships **Lines and Angles** • construct, represent, identify and describe lines and angles • estimate, measure and compare angles, and describe properties of lines and angles **Transformations** • identify, describe and apply transformations to 3D objects and 2D shapes including translations, rotations, reflections and symmetry, tessellations and dilation, enlargement and distortion **Location** • describe how objects can be located, positioned, mapped or arranged in space • describe spatial relationships using co-ordinate geometry and other representational systems such as network diagrams
Measurement The Measurement strand provides opportunities for learners to understand measurable attributes of objects and the units, relationships between units, systems and processes of measurement.	**Physical Attributes** • estimate and measure spatially organised quantities such as length, area, volume • estimate and measure non-spatially organised quantities such as capacity, mass, temperature, air pressure and density • solve a range of practical problems involving measurement • use appropriate formulas or technology to determine measurements and the calculation of rates **Time** • estimate and measure durations of time including using 12 h and 24 h analogue and digital clocks, stopwatches, calendars and timetables • solve a range of practical problems involving durations of time • choose and use units of measurement and determine required degree of accuracy within specific contexts **Graduated Scales** • read, interpret and use measurement instruments and the scales built into these instruments • determine the degree of accuracy required and the appropriate measuring equipment, units or scales to use
Chance and Data The Chance and Data strand provides opportunities for learners to develop and use chance concepts and data-handling processes.	**Chance** • apply concepts of probability to solve problems involving chance events **Data** • pose questions or make predictions that can be answered or tested with data • collect, organise and display data in many forms • summarise, interpret and analyse data using appropriate statistical methods

Strands	Elements
Number The Number strand provides opportunities for learners to develop and use number concepts and relationships, representations of number and calculation skills using mental, written and technology-assisted methods.	**Numbers and Number Systems** • understand numbers and ways of representing and describing numbers, number relationships and systems **Calculating** • understand the meanings of operations and the relationship between different operations • make reasonable estimates and calculate fluently and flexibly using a range of strategies and methods including mental, informal and formal written methods and appropriate use of technology such as calculators and spreadsheets
Algebra The Algebra strand provides opportunities for learners to develop algebraic thinking through recognising, describing and using patterns, relationships and functions to represent and analyse mathematical situations.	**Patterns** • copy, continue, complete, create, describe and represent numerical and geometrical patterns • make generalisations about numerical and geometrical patterns • identify, describe and compare qualitative and quantitative change **Relationships** • identify and use properties of commutativity, associativity and distributivity in solving equations • represent and analyse a range of mathematical situations and solve problems using equations and inequations **Representations** • identify and describe functions: linear, quadratic, exponential • represent and interpret functions in various forms: tables, graphs and equations

Working Mathematically

The Mathematics Learning Area provides opportunities for learners to engage in the process of working mathematically. Suggestions about the type of opportunities that can be provided to learners have been explicitly described in the indicators for each content strand. Working mathematically involves mathematical inquiry and its practical and theoretical application in solving problems in a range of contexts. Five interrelated components of working mathematically have been identified as follows (NTCF, 2002):

- **Appropriate and efficient application of skills, concepts and techniques in a range of contexts**

  Learners need to be able to identify, collect and organise mathematical information relevant to a task or problem. They choose a range of strategies, technologies and techniques and persist with trying alternatives until they succeed. Learners also need to justify their methods and assess the reasonableness of their solutions.

- **Effective and meaningful communication of mathematical thinking**

  Learners need to be able to interpret and express mathematical language with increasing levels of sophistication and be able to deconstruct mathematical language. Learners need to be able to explain mathematical ideas in their own words/ways, including presenting results and findings. They also need to take audience into account by using appropriate notation and terminology and use technologies such as visual aids to enhance investigative reports.

- **Appropriate and varied ways of working through mathematical problems and investigations**

  Learners must be able to work both collaboratively and independently when planning, organising, undertaking and reporting on mathematical problem-solving and investigations. In extended mathematical tasks or investigations learners will require a high degree of persistence and intrinsic motivation. In the case of collaborative work, well-developed negotiation skills and the capacity to effectively contribute to a team are required.

- **Effective and appropriate use of technologies and other equipment**

  This includes the ability to recognise, link and extend multiple representations. Learners need to be able to make good choices and justify the use of equipment, including the use of technology as a computational tool or display device. It also includes an awareness of the limitations of technology and a capacity to assess the reasonableness of the results generated through technology.

- **Generalisation**

  In the context of school mathematics, generalisation is most apparent when learners are given a context or problem that they explore and express in their own words. Exploring the problem includes organising the data, identifying a pattern, making conjectures and checking these against the data. Learners then make a generalisation, justify it and apply the generalisation to other contexts.

These components of working mathematically provide the basis for teaching, assessing and reporting the mathematical achievements of learners in a rich process-oriented manner that recognises the importance of developing deep conceptual understandings and a working mathematically orientation that is critical to the mathematical empowerment of all learners.

Summary of Key Differences between 2002 NTCF and 2009 NTCF

2002 NTCF	2009 NTCF
Outcomes are very broad with element indicators that are a combination of activities, assessment tasks and teaching ideas.	Outcomes have been broken down into elements which have been further elaborated as indicators for each strand element. The indicators have been organised into: **Knowledge and Skills** that learners are expected to understand at a given level and **Working Mathematically** that describe opportunities for learners to apply mathematical knowledge and skills in a purposeful context.

2002 NTCF	2009 NTCF
The document was based largely on the professional wisdom of classroom teachers who engaged in the writing and piloting of the NTCF 2000-2001 and A National Statement on Mathematics for Australian Schools (Australian Education Council and Curriculum Corporation, 1991).	The document is largely based on evidenced-based research including: the Structure of the Observed Learning Outcomes (SOLO), Learning Framework in Number (NSW DET), Measurement Framework (NSW DET), Levels of Geometrical Thinking (Van Hiele), First Steps Mathematics Developmental Continua (WA DET). Professional wisdom of classroom teachers has been sought through NT teachers piloting and validating the pilot documents (2007-2008), a Maths Learning Area Renewal Group who assisted with writing the document and reviews conducted by independent education consultants familiar with the context of the NTCF. The updated NTCF has been correlated to the National Statement of Learning - Mathematics Learning Area (MCEETYA, 2006) and the National Consumer and Financial Literacy Framework (MCEETYA, 2005).

National and International Assessment Programs

The National Assessment Program Literacy and Numeracy (NAPLAN) is a nationally coordinated approach to measuring and monitoring the achievement of learners against national and international standards. Learners in Years 3, 5, 7 and 9 across Australia sit a common numeracy assessment instrument in May each year. The assessment results provide a measure of how all Australian learners are performing in numeracy against national achievement bands. The NAPLAN national minimum standard and 2008 Australian Mean have been used to identify minimum and proficiency performance standards for numeracy within the NT Curriculum Framework.

Year 3

- Minimum standard is transitioning between KGP3 and Band 1
- Proficiency standard is transitioning between Band 1 and Band 2

Year 5

- Minimum standard is transitioning between Band 1 and Band 2
- Proficiency standard is transitioning between Band 2 and Band 3

Year 7

- Minimum standard is within Band 2
- Proficiency standard is within Band 3

Year 9

- Minimum standard is within Band 3
- Proficiency standard is transitioning between Band 3 and Band 4

A suite of NAP sample items can be sourced at http://www.det.nt.gov/education/teaching_and_learning/assessment_standards_reporting/nap/practice_tests.shtml

For more information about the NAP Numeracy and the current National Report go to http://www.naplan.cdu.au

The Programme for International Student Assessment (PISA) involves a sample of 15 year old learners participating in an international assessment of Reading, Mathematical and Scientific Literacy. PISA is administered every three years, with a main study focussing in Mathematical Literacy every nine years. The Mathematical Literacy component of PISA assesses the ability of learners to apply their knowledge and skills to real-life problems and situations. Participation in PISA provides an indicator of how Australia compares with other countries. The last study focussed on mathematical literacy was carried out in 2003 and involved 57 countries. A new study will be conducted in 2009. **The PISA mathematical literacy proficiency standard for fifteen year olds is within the NTCF Band 4.** For more information about PISA, including the 2006 Report, go to http://www.acer.edu.au/ozpisa/

Designing for Teaching and Learning in Mathematics

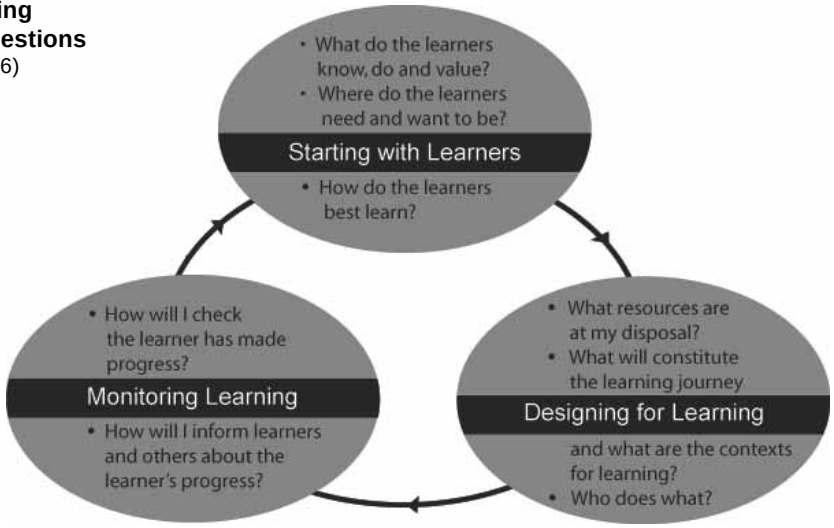
Mathematics teaching and learning programs need to provide opportunities for learners to develop the knowledge and skills to promote numerate behaviour and therefore it should be noted that numeracy will be enhanced by a cross-curriculum focus based on the principle that numeracy education is everyone's business (COAG, 2008). This commitment can be managed across-the-school by identifying key numeracy capacities in the descriptions of teaching and learning plans in other learning areas. For example, consider the following numeracy perspectives relevant to Science and English (National Curriculum Board, 2008):

Science: Practical work and problem solving across the disciplines of science require the capacity to collect, display and interpret data; use formulas flexibly in a range of situations; and use and interpret rates including concentrations, sampling, scientific notation, and significant figures.

English: Numeracy can be understood only within the context of the social, cultural, political, economic and historical practices to which it is integral. Learners need to draw on quantitative and spatial information to derive meaning from a range of fictional and factual texts encountered in the subject of English, eg written texts (including novels, picture books, plays, transcripts, newspapers, magazines and scientific reports) and oral texts (including story-telling experiences, video and theatrical presentations).

It is from this perspective that schools should work towards a minimum of 5 hours per week of mathematics for students in the primary years T-Year 6 and a minimum of 4 hours per week in the middle years and year 10. This time should include cross curricular learning (COAG, 2008).

The Eight Learning Management Questions
(Smith & Lynch 2006)



The eight learning management questions provide a guide for designing short, medium and long term learning and teaching programs. A number of curriculum, pedagogy and assessment support materials are available to assist teachers to use these design questions.

Starting with Learners

It is expected that teachers will use the learner's mathematics and numeracy progress and achievement data to identify what they know and can do. Schools collect learners NT Curriculum Framework achievement data and achievement against National achievement standards is available form Year 3, 5, 7 and 9 learners who participate in the National Assessment Program in Literacy and Numeracy (NAPLAN).

Curriculum standards contained in the mathematics Learning Progress Map describe what learners are expected to know and do and teachers are expected to teach. The achievement standards contained in the NTCF Overview and the NAPLAN achievement levels describe the expected level of achievement for each year level.

Teaching teams are expected to use these standards, with the data on actual student achievement and progress, to identify the targeted outcomes for the learning programs.

Designing for Learning

The learning journey should provide learning experiences that enable learners to create or construct their own mathematical knowledge and link ideas to existing concepts through careful and competent guidance by the teacher, posing questions, challenges and problems while not telling the answers. Such a teaching and learning program becomes learner-centred, building upon and respecting the prior knowledge and experiences of learners and challenging the existing conceptions of the learner in such a way that the learner feels a need to accommodate new information or ideas.

Learning experiences should therefore focus on learners developing knowledge and skills to promote more sophisticated mathematical thinking and problem-solving. Such a learning environment can be realised by utilising cooperative, collaborative and dialogic strategies in teacher-led, peer and individually driven learning experiences.

Teaching and learning programs should provide opportunities for learners to:

- develop a range of mathematical concepts, procedures and skills and a repertoire or 'strategies toolkit' of mathematical processes, appreciations and dispositions to choose and use mathematics in order to solve familiar and unfamiliar problems. These concepts have been elaborated in the Knowledge and Skills indicators, while strategic processes have been elaborated in the Working Mathematically indicators.

- develop a suite of generalised procedures that can be applied to a range of problems and situations rather than routine procedural tasks. There should be a focus on learners analysing, giving reasons and explaining strategies for solutions to tasks and problems rather than the rote memorization of facts and rules. The process of thinking mathematically and how to approach problem solving is more important than memorising one way of getting an answer (COAG, 2008). Learners should be encouraged to develop a range of mental calculation and estimation strategies including developing a range of non-standard procedures to solve problems, especially in the early years (McIntosh, 2005).

- engage with a variety of mathematical task types including those:
  - that give students choice of approach
  - for which there is an optimal approach
  - for which there are various possible solutions
  - which have a single correct answer
  - that prompt the development and use of mathematical models
  - that incorporate ideas across different content strands in the Mathematics Learning Area and Learning Areas other than mathematics

- actively engage in purposeful, achievable but challenging mathematics learning experiences that are inclusive and can be differentiated to cater for the needs of a range of learners in a class, and be presented in real-world contexts

- learn how to use language as a tool for reflecting and communicating mathematical learning. Teaching and learning programs should build on the learners' everyday language and increasingly develop the capacities of learners to interpret and use mathematical expressions. The language of mathematics needs to be explicitly taught and it needs to be recognised that language can provide a formidable barrier to both understanding of mathematics concepts and in providing learners access to assessment items aimed at eliciting mathematical understandings. Mathematical language should be modelled and scaffolded in each strand at each band level (COAG, 2008).

- use digital technologies effectively to enhance the relevance of the content and processes for learning mathematics, including the appropriate use of calculators across all year levels, software packages including interactive geometry programs and spreadsheets, and web-based tools and resources (COAG, 2008).

Monitoring Learning
The major purpose of assessment is the improvement of learning. All learning experiences have the potential to assess learners' current knowledge and to diagnose misconceptions, so that teachers are able to plan subsequent learning experiences and inform future action for learners.

To assess the full range of learning outcomes, a range of assessment strategies should be used.

Some examples of assessment strategies in mathematics:

Strategy	Working Mathematically outcomes addressed
Questioning	
Written test	Application (content knowledge)
Diagnostic interview understanding)	Application and communication (conceptual
Open ended questions	Application and generalisation
Directed investigation	Investigation and communication
Open investigation	Investigation, generalisation, application, communication
Problem solving task	Generalisation, application and communication
Recording / Presenting	
Answer sheet	Application (content knowledge)
Concept map	Communication (conceptual understanding)
Written report	Communication
Oral presentation	Communication
Practical demonstration	Application (procedural skills)
Multimedia presentation	Technology and communication
Spreadsheet or graph	Technology, application, communication
Table or chart	Application, communication
Model or construction	Application, communication
Diagrams or pictures	Application, communication
Reflecting	
Student learning portfolios	Communication, application
Annotated work samples	Communication, application
Self-assessment sheets	Application, communication
Task reflection sheets	Application, generalisation
Rubric	Application, generalisation
Checklist	Application, generalisation
Newman's error analysis	Application, communication

Samples of assessment tasks with annotated work samples aligned to the NTCF (2002) can be found at:

http://www.det.nt.gov.au/education/teaching_and_learning/assessment_standards_reporting/evidence_of_learning/maths.shtml

A range of useful resources that support the principles of assessment for learning have also been noted in the reference list below.

Curriculum, Pedagogy and Assessment Support Materials with Professional Learning

- Count Me in Too - Number - (NSW DET)
  - Learning Framework in Number
  - Schedule for Early Number Assessment
  - Developing Efficient Numeracy Strategies
  - Teaching Fractions: Pikelets and Lamingtons
  - Teaching about Pattern and Algebra
- Teaching Measurement - (NSW DET)
  - Teaching Measurement
- Teaching Space and Geometry - (NSW DET)
  - Teaching Space and Geometry
  - Teaching about Angles
- Maths300 - (Curriculum Corporation)
  - Maths300 web-based Lesson Library with related software
- Problem-solving Task Centre - (Curriculum Corporation)
  - Problem-solving Task Centre – collection of mathematical problems with related hands-on materials for learners
- QuickSmart® Numeracy Program – professional learning program for teachers and paraprofessionals with related resource materials
  - QuickSmart® is a fourth-phase intervention program designed for learners in the Primary and Middle Years
- Consumer and Financial Literacy Professional Learning Program - (Curriculum Corporation)

Recommended Curriculum, Pedagogy and Assessment Support Materials

- Understanding Money
  http://www.understandingmoney.gov.au/
- Census@School - Australian Bureau of Statistics
  http://www.abs.gov.au
- Financial Literacy – Understanding Money
  http://www.understandingmoney.gov.au/Content/consumer
- National Financial Literacy Curriculum Resource
  http://www.about.commbank.com.au/group_display/O,1922,CH3150%5FTS11626,00.html
- Assessment for Learning, Curriculum Corporation
  http://cms.curriculum.edu.au/assessment
- Maths300
  http://www.curriculum.edu.au/maths300/index.htm
- Mathematics Task Centre Project
  http://www.curriculum.edu.au/maths300/index.htm
- MoneyStuff
  www.moneystuff.net.au
- NZMaths
  http://www.nzmaths.co.au
- The Le@rning Federation, Mathematic Learning Objects
  http://www.scootle.edu.au/ec/p/home

- MakingCents (Early Years, Middle Primary and Upper Primary resources) www.makingcents.com.au
- Burnett, J., Turton, A. & Irons, C. (2006). Geo Series; Geopaperpolygons, Geoplanepuzzles, Geoallaboutangles, Geo Faces and Frames. Australia: Origo Education. Available from Origo Education and Mathematical Association of Victoria.
- Cabrilog, (2007). Cabri geometry II Plus and Cabri 3D (interactive geometry software). France: Cabrilog. Unlimited site bundle available from Australian Association of Mathematics Teachers.
- Downton, A. et.al, (2006). Mathematics Assessment for Learning: Rich Tasks & Work Samples, Mathematics Teaching and Learning Centre, Australian Catholic University. Melbourne, Australia. Available from Australian Association of Mathematics Teachers.
- Flewelling, G. (2005). Teaching with Rich Tasks Handbook (2nd Edition). Australia: AAMT. Available from Australian Association of Mathematics Teachers.
- Hillbrick, A. (2004). Tuning in with Task Cards (Lower, Middle and Upper Primary editions). Australia: Curriculum Corporation.
- Lewis, E. et.al. (2004). Daily Work-outs Levels introduction - 6. Australia: Oxford University Press. Available from Dymocks.
- Lovitt, C. & Clarke, D. (1988). The Mathematics Curriculum and Teaching Program professional development package. Activity Bank, Canberra: Curriculum Development Centre.
- Lovitt, C. & Lowe, (2005). Reality in Maths Education (re-printed series). Australia: Mathematical Society of Victoria. Available from MAV. Reality in Maths Education (re-printed series) and Mathematical Association of Victoria.
- Lowe, I. (2005). Active Learning (series). Australia: Mathematical Association of Victoria. Available from Mathematical Association of Victoria.
- Lowe, I et.al. (1993). Access to Algebra (Books 1 - 4), Australia: Curriculum Corporation.
- NSW DET, (2007). Count Me in Too! Learning Framework in Number- 2nd Edition. Australia. Available NSW DET Sales.
- NSW DET, (1999). Count Me in Too! Developing Efficient Numeracy Strategies Stage One, Australia. Available NSW DET Sales and Australian Association of Mathematics Teachers.
- NSW DET, (2003). Count Me in Too! Developing Efficient Numeracy Strategies Stage Two, Australia. Available NSW DET Sales and Australian Association of Mathematics Teachers.
- NSW DET, (2008). Fractions: pikelets and lamingtons (updated). Australia: NSW DET. Available NSW DET Sales.
- NSW DET, (2003). Teaching about angles Stage 2. Australia: NSW DET. Available NSW DET Sales.
- NSW DET, (2005). Talking about Pattern and Algebra. Australia: NSW DET. Available NSW DET Sales.
- NSW DET, (2003). Teaching Measurement Early Stage 1/Stage 1. Australia: NSW DET. Available NSW DET Sales.
- NSW DET, (2004). Teaching Measurement Stage 2/Stage 3. Australia: NSW DET. Available NSW DET Sales.
- NSW DET, (2008). Teaching Space and Geometry. Australia: NSW DET. Available NSW DET Sales.
- Sullivan, P. & Lilburn, P. (2004). Open-ended Maths Activities – Using 'good' questions to enhance learning. Australia: Oxford University Press. Available from Australian Association of Mathematics Teachers.
- Warren, E. (2006). Algebra for All. Australia: Origo Education. Available Origo Education.

- WA Department of Education (2004). First Steps Mathematics – Number. Australia: WA Education Department. Available Rigby and Dymocks.

- WA Department of Education (2005). First Steps Mathematics – Measurement. Australia: WA Education Department. Available Rigby and Dymocks.

- WA Department of Education (2005). First Steps Mathematics – Space. Australia: WA Education Department. Available Rigby and Dymocks.

- WA Department of Education (2005). First Steps Mathematics – Chance and Data. Australia: WA Education Department. Available Rigby and Dymocks.

Recognised Professional Associations

The **Australian Association of Mathematics Teachers (AAMT)** is the nation's premier organisation of mathematics educators. The AAMT provides a range of services to its members including conducting national professional learning activities and an online store which markets quality teaching and learning materials. The AAMT facilitates professional networking of teachers through an online community, distribution of regular newsletters and publication of three refereed journals: Australian Primary Mathematics Classroom, The Australian Mathematics Teacher and Australian Senior Mathematics Journal. The AAMT does not have direct membership; you need to join through the Mathematics Teachers Association of the Northern Territory and then you are automatically a member of AAMT.

The **Mathematics Teachers Association of the Northern Territory (MTANT)** is the local affiliated association to the AAMT. MTANT is active in providing professional learning to teachers of mathematics in the Northern Territory and promotes a range of learner activities to enhance numeracy outcomes.

For further details about these professional associations visit
AAMT http://www.aamt.edu.au **MTANT** http://mtant.org.au

References:

Australian Association of Mathematics Teachers (AAMT), (2008). *Position Paper on The Practice of Assessing Mathematics Learning*. Retrieved December 10, 2008 from http://www.aamt.edu.au/documentation/statements

Australian Association of Mathematics Teachers (AAMT) (2006). *Standards for Excellence in Teaching Mathematics is Australian Schools*. Retrieved December 10, 2008 from http://www.aamt.edu.au

Australian Association of Mathematics Teachers (AAMT) (2006). *Quality Mathematics in the Middle Years Communique*. Proceedings of the National Quality Mathematics in the Middle Years Conference convened by AAMT in Fremantle, 2005. Retrieved March 14, 2007 from http://www.aamt.edu.au/documentation/statements

Australian Association of Mathematics Teachers (AAMT) (1998). *Policy on Numeracy Education in Schools.* Retrieved September 2008 from http://www.aamt.edu.au/Documentation/Statements/Policy-on-Numeracy-Education-in-Schools-1998

Biggs, J.B. & Collis, K.F. (1982). *Evaluating the quality of learning*: *the SOLO Taxonomy.* New York: Academic Press

Caney, A. (2005). *Focus on Learning Problems in Mathematic*s. Development of Reasoning about Random Events. USA. Retrieved 18 March, 2009 from http://www.thefreelibrary.com/_/print/PrintArticle.aspx?id=152872872

Clarke, D. (1989). *Assessment Alternatives in Mathematics*. Canberra: Curriculum Development Centre

Council of Australian Governments (COAG) (2008). *National Numeracy Review*. Final Report

Curriculum Corporation (2008). *Maths300.* Australia: Curriculum Corporation. Retrieved September 16, 2008 from http://www1.curriculum.edu.au/maths300/index.htm

Curriculum Corporation (1977-2008). *Mathematics Task Centre Project*. Australia: Curriculum Corporation.

Details available online September, 2008 at http://www1.curriculum.edu.au/maths300/index.htm

Downton, A. et.al (2006). *Mathematics Assessment for Learning*: *Rich Tasks and Work Samples*. Melbourne, Australia: Mathematics Teaching and Learning Centre, Australian Catholic University

Flewelling, G. (2005). *Teaching with Rich Tasks Handbook* (2nd Edition). Australia: AAMT

McIntosh, A. (2005). *Mental Computation: A Strategies Approach*. Australia: Department of Education,Tasmania

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) (2008). The Melbourne *Declaration on Education Goals for Young Australians*. Retrieved December 12, 2008 from www.mceetya.edu.au

Ministerial Council on Education, Employment, Training and Youth Affairs (MYCEETYA) (2006). *National Consistency in Curriculum Outcomes - Statement of Learning and Professional Elaborations for Mathematics*. Retrieved December 5, 2008 from www.mceetya.edu.au

Ministerial Council on Education, Employment, Training and Youth Affairs (MYCEETYA) (2005). *National Consumer and Financial Literacy Framework*. Retrieved December 4, 2008 from www.mceetya.edu.au

Ministerial Council on Education, Employment, Training and Youth Affairs (MYCEETYA), (1997). *National Report on Schooling in Australia*. Retrieved December 4, 2008 from www.mceetya.edu.au

National Curriculum Board, (2008). *National Mathematics Curriculum: Framing Paper*. Retrieved December, 2008 from http://www.ncb.org.au

NT Department of Employment, Education and Training (NT DEET) (2005). *The Framework for the Principles and Policy for the Middle Years in the Northern Territory*. Retrieved September 7, 2008 from
http://www.betterschools.nt.gov.au/students_learning/middle_years/docs/principles_policies_framework.pdf

NT Department of Employment, Education and Training (NT DEET) (2002). *Northern Territory Curriculum Framework (NTCF)*. Retrieved September 5, 2008 from
http://www.det.nt.gov.au/education/teaching_and_learning/curriculum/ntcf/

Pegg, J. & Panizzon, D. (2004). *Assessing Changing Assessment Agendas: Experience of Secondary Mathematics Teachers in Rural NSW*. MERGA. Retrieved September 9, 2008 from
http://www.merga.net.au/documents/RP522004.pdf

Pegg, J., Lynch, T. & Panizzon, D. (2007). *An Exceptional Schooling Outcomes Project Numeracy Research in NSW Primary Schools Project*: *What's making the Difference?* DEST, NSW DET. Qld: Post Pressed. Details available online at https://www.det.nsw.edu.au/research/currentProjects/index.htm

Smith, A & Jatan, H. (2007). *Some Ideas for Constructing Rubrics*. Retrieved July 3, 2007 from
http://www.ltag.education.tas.gov.au

Smith, R. & Lynch, D. (2006). *The Rise of the Learning Manager*. Australia: Pearson

Van Hiele, P, M.(1999). *Developing Geometric Thinking Through Activities That Begin With Play*. *Teaching children mathematics*, 5(6), pp. 310 - 316. Information available online December 2008 at
http://images.rbs.org/cognitive/van_hiele.shtml
http://nrich.maths.org/public/viewewr.php?obj_id=2487
http://www.gogeometry.com/mindmap/van_hiele_geometry_level.html

Wiliam, D. (2005). *Keeping learning on track: Formative assessment and the regulation of learning*. 20th Biennial Conference of the Australian Association of Mathematics Teachers, Sydney

Wiliam, D. & Black, P.J. (2002). *Assessment for Learning: 10 Principles*. UK: Assessment Reform Group. Retrieved December 3, 2008 from http://www.assessment-reform-group.org/

Key Growth Point 1	Key Growth Point 2	Key Growth Point 3
S KGP 1 Space Learners use intentional communication strategies to interact with people, objects and activities.	**S KGP 2 Space** Learners describe 3D objects, 2D shapes and lines through play, using everyday language. They visually discriminate between changes in the orientation of 3D objects and 2D shapes and describe positions of known everyday objects.	**S KGP 3 Space** Learners identify and name common geometric 2D shapes, locate these shapes within the physical environment and make links between these shapes and the physical function of corresponding objects. They correctly use and interpret positional and directional language.
M KGP 1 Measurement Learners use intentional communication strategies to interact with people, objects and activities.	**M KGP 2 Measurement** Learners differentiate the measurable attributes of an object. They use spatial language when visually comparing objects and indicate awareness of the order of routine events and stages of daily cycles.	**M KGP 3 Measurement** Learners directly compare and order two or more objects or events with respect to a specified attribute. They demonstrate an emerging understanding of the relationship between quantity and measurement.
CD KGP 1 Chance and Data Learners use intentional communication strategies to interact with people, objects and activities.	**CD KGP 2 Chance and Data** Learners use everyday language to state opinions on the possibility of a given event occurring. They identify common attributes in a collection of objects.	**CD KGP 3 Chance and Data** Learners use reasoning to determine whether a given event is certain, possible or impossible and recognise that some events have a strong random element. They categorise collections of objects and determine which category is the largest.
N KGP 1 Number Learners use intentional communication strategies to interact with people, objects and activities.	**N KGP 2 Number** Learners distinguish small collections by size. They recognise and repeat number words, distinguish number symbols from other symbols and understand that numbers are linked to the idea of ‘amount’.	**N KGP 3 Number** Learners match number words and symbols to collections. They count items, order and record small numbers. Learners represent or describe situations involving addition and subtraction by drawing, modelling or acting out. They create approximately equal groups by sharing.
A KGP 1 Algebra Learners use intentional communication strategies to interact with people, objects and activities.	**A KGP 2 Algebra** Learners reproduce a given repeating physical pattern.	**A KGP 3 Algebra** Learners recognise and continue repeating physical or kinaesthetic patterns.

Band 1	Band 2	Band 3
S 1 Space Learners name and construct some familiar 3D objects, name and represent a range of 2D shapes and identify some of their features. They create maps from a personal perspective to describe familiar locations.	**S 2 Space** Learners identify and list geometric features including comparative measures of angles for a range of 3D objects and 2D shapes. They sort and construct 3D objects and represent 2D shapes according to specified criteria. Learners transform 2D shapes. They interpret maps and plans which may include compass points, keys and grids.	**S 3 Space** Learners identify relevant properties of geometric 3D objects and 2D shapes in order to construct or classify them in accordance with formal definitions. They measure angles to the nearest degree and demonstrate a developing sense of scale and proportion, creating accurate scale maps and drawings.
M 1 Measurement Learners quantify attributes of objects and events by measuring formal units of length with informal units. They ensure units are uniform and spatially aligned. They use the same units when comparing attributes and read on the hour and half hour.	**M 2 Measurement** Learners estimate and measure attributes of objects and events using formal units. They describe the relationship between unit size and the number of units in a measure. They combine part units to estimate a total.	**M 3 Measurement** Learners recognise that the accuracy of measurement can be improved by subdividing the unit used. They perform and interpret calculations using measurement data in order to solve problems.
CD 1 Chance and Data Learners recognise that some events are more likely to occur than others. They understand the need for a common baseline and spatial alignment when comparing columns of physical collections.	**CD 2 Chance and Data** Learners list possible outcomes for a given situation. They use reasoning to explain why one event is more likely than another.	**CD 3 Chance and Data** Learners quantify chance by pairing chance concepts with numeric values on a scale from 0 to 1. They use quantitative data to rank discrete events in order of probability and determine approximate numeric probabilities for other events. Learners discriminate between discrete and continuous data.
N 1 Number Learners describe, order and model whole numbers in a variety of ways. They investigate and represent situations involving the four operations using a number of different strategies including the use of manipulatives, stories and pictures.	**N 2 Number** Learners use an emerging understanding of place value to describe, model and order whole numbers. They use efficient mental strategies to add and subtract, multiply and divide using equal grouping and counting.	**N 3 Number** Learners describe and manipulate whole numbers and decimals, demonstrating knowledge of place value. They recognise that the relationship between multiplication and division is based on equal partitioning and can apply strategies to multiplication and division as well as visualise and manipulate fractions, decimals, key percentages and simple ratios.
A 1 Algebra Learners describe physical patterns formed by repeated addition or subtraction of a fixed number of elements or use a simple rule to generate such a pattern.	**A 2 Algebra** Learners describe physical patterns involving change in the difference between successive numbers.	**A 3 Algebra** Learners describe and continue number patterns involving repeated multiplication or division. They convert a physical pattern or number pattern to a table of values.

Band 4	Band 5	Band 5+
S 4 Space Learners describe classes of 2D shapes and the relationships between classes, in terms of the properties of their constituent shapes. They mentally manipulate geometric 3D objects and 2D shapes. They use coordinate systems to determine position.	**S 5 Space** Learners apply derived relationships, conjectures and theorems to solve problems involving geometric 3D objects and 2D shapes. They integrate location concepts with geometric relationships to conduct transformations and solve location problems.	**S 5+ Space** Learners apply knowledge of the relationships between geometric properties to conduct formal logical processes. They differentiate between conjectures and theorems, and locate errors in attempted deductive proofs. They transform geometric 2D shapes on a Cartesian plane. They plot and convert polar coordinates.
M 4 Measurement Learners recognise that all measurement is approximate, stating ranges of accuracy for measurement data. They combine the attributes of familiar objects and events to determine useful ratios and use these to solve problems.	**M 5 Measurement** Learners quantify the accuracy of measurement and measurement calculations through the use of significant figures. They apply Base 10 understanding to combine scientific notation with metric prefixes in specifying very large or small quantities and manipulate derived relationships to solve problems.	**M 5+ Measurement** Learners develop models to describe general forms of unfamiliar relationships between attributes. They explore and represent rates of change through the use of calculus and the flexible application of exponential scales. They perform calculations involving both scalar and vector quantities.
CD 4 Chance and Data Learners calculate theoretical probabilities for given discrete events. Learners interpret theoretical probabilities or data tables to make and justify comparisons or predictions. They discriminate between 'sample' and 'census' data. They calculate and interpret measures of central tendency.	**CD 5 Chance and Data** Learners determine theoretical probabilities of independent, two step events. They display data to show frequency and spread. They interpret and critique their own and published data, making adjustments and inferences where appropriate.	**CD 5+ Chance and Data** Learners determine theoretical probabilities of complex events. They explain how the uncertainty of a prediction is a function of the amount of variation in a dataset. They explain and calculate standard deviation.
N 4 Number Learners extend knowledge of place value and multiplicative strategies to whole numbers and fractional numbers and compare and manipulate a wide variety of decimals, common fractions, percentages and ratios. They order and manipulate integers and apply an emerging understanding of the inverse relationship between powers and roots.	**N 5 Number** Learners combine system knowledge of place value with formal notation to represent, order and manipulate numbers of any size; accordingly they use scientific notation, read and represent recurring decimals and specify and represent significant figures and degrees of accuracy.	**N 5+ Number** Learners describe the difference between rational and irrational numbers including the distinction between recurring and infinite non-recurring decimals. They order, manipulate and represent surds in different forms. Learners represent, order and manipulate logarithms.
A 4 Algebra Learners describe a one or two-operation number sequence symbolically, in terms of a general rule. They use a general rule to determine the nth term of a sequence or, given the term, determine its position in the sequence. They apply symbolic notation involving the four operations to solve problems.	**A 5 Algebra** Learners explore and interpret patterns revealed by graphing more complex equations including quadratic functions.	**A 5+ Algebra** Learners explore and interpret patterns revealed by graphing a greater range of complex functions including logs, circles, hyperbolics and exponentials.